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(54) Title: HOLLOW MOLDED-TO-SHAPE EXPANDABLE SEALER

(57) Abstract

A hollow molded-to-shape expandable sealer is molded in a blow molding or rotational molding process which can be installed in a body cavity and then expanded to fill the cavity during an electro-coat or paint drying or curing process in order to block any air and moisture penetration into the body cavity.

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HOLLOW MOLDED-TO-SHAPE EXPANDABLE SEALER

FIELD OF THE INVENTION

The present invention generally relates to a hollow molded-to-shape expandable sealer and more particularly, relates to a hollow molded-to-shape expandable sealer that can be used either with or without an internal core in sealing a body cavity against air, water and dust penetration.

BACKGROUND OF THE INVENTION

Various articles of manufacture are made with cavities located in areas where wind, water and dust, for example, can enter and thus causing undesirable wind-generated noises and increasing the likelihood of rusting of the article due to moisture trapped in the cavities. The problem is particularly severe in cavities formed in a vehicle body when an automobile is manufactured. For instance, an automobile A-pillar which is the part that outlines portion of the windshield and the front windows in addition to providing support to the roof structure is particularly prone to such wind noise. Other hollow cavities on a vehicle body such as the motor rail, the front body hinge pillar, the rocker, the B-pillar, the sail, the C-pillar, the wheel

housing to quarter), and the cowl are similarly prone to wind noises and moisture problems.

As the automobile manufacturing technology progressed in recent years, the passenger area of the automobile has been made quieter and as a result, the automobile occupants are more conscious of noises generated by the vehicle movement. One of the major sources of such noises has been identified to be the cavities created when a vehicle body is assembled from various sheet metal parts to form body sections such as the pillar sections. The pillars on a vehicle body are commonly designated as "A", "B", and "C" pillars. The various pillars connect the lower part of a vehicle body to the roof and thus providing the roof support. The A-pillars are those at the front quarters of the passenger compartment on either side of the windshield and immediately forward of the front side doors. The B-pillars are those between the front and rear side doors of a typical 4-door sedan and the like. The C-pillars are at the rear quarter of a passenger compartment on either side of the rear window and aft of all of the passenger compartment side doors in a typical 2-door coupe or in a typical 4-door sedan.

In the manufacturing process, the pillars are made from inner and outer sheet metal panels which fit together so that mating flanges are welded in place to form the particular automobile body sections. It is noted that most of the complimentary panel areas of the

pillar are spaced apart to form a hollow space or cavity between the panels. This type of void or cavity has been found to transmit undesirable wind noises and subjects the metal to rust and deterioration when moisture is trapped therein. Some possible sources of moisture include condensation, rain, snow, car washes, and road moisture which is splattered on the automobile by passing vehicles. The road moisture is particularly undesirable since it often contains rust accelerators such as salt used on roadways for deicing. It is therefore desirable to prevent the flow of air through hollow cavities in a vehicle body to prevent water and dust from entering the cavity and causing rust or other problems.

In one of the important steps of the automobile manufacturing process, the vehicle body is coated with anti-rust electro-coat or paints before the assembly of the vehicle is completed. These electro-coat or paints are then dried and cured by baking the entire vehicle body in ovens at temperatures and for a length of time sufficient for the electro-coat or paints to dry and to adhere to the inner and outer surfaces of the body.

In an effort to minimize air flow in hollow cavities in a vehicle body, a technique has been adopted wherein a conduit for transporting sealer in liquid form is inserted into each of the body cavity access holes. A two-part foaming sealer is then dispensed into

the empty space of the pillar. The process is frequently performed after the pillars have been assembled to the vehicle body. The process must be performed after the electro-coat or paint has been applied and cured. The sealer is frequently mixed together from two components, one of which contains a curing agent, just prior to the time of its application and pumped into the pillars so that the components react to expand the sealer after application. The reaction characteristics and the dispensing time of the sealer application are critical and must be controlled precisely, since the sealer must retain its fluid flow characteristics until the cavity of the pillar is sufficiently filled in order to sufficiently block the pillar. In practice, some of the sealer inevitably flows out of the pillar before the sealer is properly expanded and loses its fluid flow characteristics. This results in the necessity of a messy clean-up task. In addition, a hole throughout the length of the pillar may also result which allows air to flow through the pillar and moisture to enter into the cavity.

Another attempt to solve the air flow and the moisture entrapment problems in vehicle body cavities involves the use of a heat-expandable sealer introduced into the appropriate cavities during body construction which does not require a premixing step immediately before the application. The sealer is expanded and cured by the heat applied to the vehicle body section during the electro-coat or paint drying and curing cycle. These type of heat-expandable sealers,

frequently used in the solid form of a extruded sheet or profile, are made of high cost materials. When a relatively large body cavity needs to be filled, the cost of using this type of heat-expandable sealer material becomes prohibitive or impractical. Furthermore, it is difficult to fill a large body cavity with sealers in an extruded sheet or profile form without the use of a supporting platform. The total heating time required to achieve the maximum expansion of a large volume sealer may also be prohibitive for a high volume production process.

It is therefore an object of the present invention to provide a sealer for use in sealing body cavities that is a hollow molded-to-shape expandable sealer.

It is another object of the present invention to provide a hollow molded-to-shape expandable sealer for sealing body cavities that does not have the drawbacks or shortcomings of the prior art sealers.

It is a further object of the present invention to provide a hollow molded-to-shape expandable sealer that can be heat activated to expand when installed in a body cavity.

It is another further object of the present invention to provide a hollow molded-to-shape expandable sealer for sealing body cavities to prevent air flow through and moisture penetration.

It is still another object of the present invention to provide a hollow molded-to-shape expandable sealer that can be filled with an internal core for additional support and body structure enhancement.

It is yet another object of the present invention to provide a molded-to-shape expandable sealer for sealing automobile body cavities that is filled with a light weight cellular material for support.

It is still another further object of the present invention to provide a hollow molded-to-shape expandable sealer for sealing automobile body cavities that can be molded in a blow molding process.

It is yet another further object of the present invention to provide a hollow molded-to-shape expandable sealer for sealing automobile body cavities that can be manufactured in a rotational molding process.

SUMMARY OF THE INVENTION

In accordance with the present invention, a hollow molded-to-shape expandable sealer for sealing body cavities in an automobile or other structures that can be activated by heat, radiation, or moisture is provided. The sealer provides design flexibility and

more efficient use of material due to the difficulty of heating a thick part in a limited cycle time.

In a preferred embodiment, a hollow molded-to-shape expandable sealer is molded in a blow molding, rotational molding or gas assisted injection molding process. The expandable sealer can be first installed in a body cavity and then expanded to fill the cavity during a electro-coat and paint drying or curing process to block any dust and moisture penetration and to attenuate any sound transmission. The sealer can be blow molded or rotational molded of a heat activated expandable material such as ethylene vinyl acetate, ethylene propylene diene monomer (EPDM), or other ethylene copolymers and terpolymers, styrene butadiene rubber (SBR) or butyl rubber. After installed in a body cavity, the sealer expands to fill the cavity and to attenuate any sound transmission and moisture penetration during electro-coat or paint drying and curing process when the vehicle is sent through an oven at between approximately 240°F to 450°F.

In an alternate embodiment, the hollow molded-to-shape expandable sealer is filled with a light weight low cost internal core material for additional support. The internal core material may be a polyurea, or epoxy foam or any other suitable material that can stand up to a temperature of 450°F for 30 minutes. The internal core provides additional support for the hollow bladder when installed in a body

cavity. It is particularly suitable for cavities of larger sizes. The internal core provides support and prevents possible collapse of the sealer when used in a large cavity application.

The present invention is further directed to a method of making a molded-to-shape expandable sealer that is filled with an internal core material. The method includes the steps of first blow molding or rotational molding a hollow molded-to-shape expandable sealer shell and then filling the shell with a light weight and low cost foamable or other suitable material.

DETAILED DESCRIPTION OF THE PREFERRED AND THE ALTERNATE EMBODIMENTS

The base material used for the present invention hollow molded-to-shape expandable sealer can be selected from ethylene vinyl acetate, ethylene propylene diene monomer (EPDM), butyl rubber, styrene butadiene rubber (SBR) or any other ethylene copolymers and terpolymers. The heat expandable sealer may also contain a tackifying resin, filler, blowing agent, curing agent, adhesion promoters, or corrosion inhibitors. The hollow expandable sealer can be molded-to-shape by any one of the molding methods of blow molding, rotational molding, gas assisted injection molding, resin casting, slush molding, steam pressure forming or any other suitable forming methods.

In a blow molding process, the basic process involves the step of first producing a plastic parison (or preform) in the shape of a tube, placing the parison into a closed 2-piece mold wherein the cavity of the mold represents the outside shape of the part to be produced, injecting air into the heated parison to blow it out against the mold cavity, cooling the expanded parison, opening the mold and removing a rigid blow molded part. In an extrusion blow molding process, an unsupported parison is used. In an injection blow molding process, a parison that is supported on a metal core pin is used. The advantages made possible by an extrusion blow molding process include a high rate of production, a low tooling cost, and a wide selection of molding equipment suppliers.

In a blow molding process, the melt process that occurs in the extruder or in the injection molding machine must be taken into consideration in order to produce an ideal parison of controlled rheology and melt characteristics. For instance, in an extrusion blow molding process, a parison is formed by an extruder wherein plastic pellets are melted by shear heat when the pellets are transferred between a heated barrel and an extruder screw as the pellets pass through the extruder. When a parison exits a die of the extruder, a split cavity mold closes around the parison and pinches one end. Compressed air inflates the parison against the hollow blow mold surfaces which cool the inflated parison to the blow mold

configuration. Various techniques are used to introduce air into the parison such as through an extrusion die mandrel or through a blow pin.

In a rotational molding technique, a measured amount of plastic resin is charged into a warm mold which is rotated in an oven about two perpendicular axes. Centrifugal force distributes the plastic evenly throughout the mold and the heat melts and fuses the charge to the shape of the cavity. After the mold is removed and cooled, a finished part can be extracted. The advantages of a rotational molding process are low mold cost, strain-free parts, and uniform wall thickness. Plastic powder is frequently used in the molding process where they are charged in pre-weighed amounts into one-half of the mold, the two mold halves are then clamped together and rotated in two planes at right angles to one another in a heated oven.

The following are examples of various compositions and methods used in molding the present invention hollow molded-to-shape expandable sealer.

Example 1

Material	Weight Percent
Ethylene/Vinyl Acetate/Acid Terpolymer (Elvax®)	95%
Benzene sulphonyl hydrazide (Celogen® OT)	3.62%
Azodicarbonamide (Celogen® AZ-130)	1.81%
N-butyl-4, 4-bis (t-butylperoxy) valerate (Varox® 230XL)	0.63%
α, α'-bis (t-butylperoxy) t-butylperoxy diisopropylbenzene (Varox® 802-40KE)	1.63%
Diethylene glycol	1.81%

The composition shown in Example 1 is blow molded in a single shot blow molding machine. The parison or shot weight used is 247 grams resulting in a parison having a wall thickness of 1.5 mm. The total cycle time required is 34.5 seconds which include an injection time of 2.2 seconds and an in-mold time of 20 seconds. The barrel of the extruder was heated to a zone temperature profile of 165°F, 157°F, 198°F, 184°F, and 181°F wherein the 165°F indicates the temperature at the hopper/throat region while 181°F represents the temperature of the parison. The clamping pressure used on the mold platens is 750 psi and the blow air pressure used is 85 psi. The mold temperature was maintained at 55°F. The parison wall thickness profile was monitored which indicated that a relatively uniform wall thickness was maintained.

Example 2

Material	Weight Percent
Ethylene/Vinyl Acetate Copolymer (Elvax® 450)	58.5%
Ethylene/Vinyl Acetate Copolymer (Elvax® 360)	30%
Hydrocarbon Tackifying resin (Escorez® 5300)	2.51%
Benzene sulphonyl hydrazide (Celogen® OT)	3.62%
Azodicarbonamide (Celogen® AZ-130)	1.81%
N-butyl-4, 4-bis (t-butylperoxy) valerate (Varox® 230XL)	0.63%
α, α'-bis (t-butylperoxy) diisopropylbenzene (Varox® 802-40KE)	1.63%
Diethylene Glycol	1.30%

The composition shown in Example 2 is blow molded into a hollow molded-to-shape expandable sealer in a blow molding apparatus similar to that used in Example 1.

Example 3

Material	Weight Percent
Ethylene/Vinyl Acetate/Acid terpolymer (Elvax® 4260)	60.5%
Ethylene/Vinyl Acetate Copolymer (Elvax® 360)	12%
Ethylene/Vinyl Acetate Copolymer (Elvax® 450)	18%
Benzene sulphonyl hydrazide (Celogen® OT)	3.62%
Azodicarbonamide (Celogen® AZ-120)	1.81%
N-butyl-4, 4-bis (t-butylperoxy) valerate (Varox® 230XL)	0.63%
α, α'-bis (t-butylperoxy) diisopropylbenzene (Varox® 802-40KE)	1.63%
Diethylene Glycol	1.81%

The composition shown in Example 3 is blow molded into hollow expandable sealers according to the method shown in Example 1.

Example 4

Material	Weight Percent
Ethylene/Vinyl Acetate/Acid terpolymer (Elvax® 4260)	90.5%
Benzene sulphonyl hydrazide (Celogen® OT)	3.62%
Azodicarbonamide (Celogen® AZ-130)	1.81%
N-butyl-4, 4-bis (t-butylperoxy) valerate (Varox® 230XL)	0.63%
α, α'-bis (t-butylperoxy) diisopropylbenzene (Varox® 802-40KE)	1.63%
Diethylene Glycol	1.81%

The composition shown in Example 4 is blow molded into hollow expandable sealers according to the method shown in Example 1.

Hollow molded-to-shape expandable sealers molded of the compositions shown in Examples 1 through 4 are successfully tested in automobile body cavities to seal out wind and road noise, water, dust,

fuel vapors and other airborne materials from entering the automobile body. It should be noted that other than the A-pillar of an automobile, automobile body cavities such as the motor rail, the front body hinge pillar, the rocker, the B-pillar, the rear quarter lower to wheel house, the sail, the C-pillar, the wheel house to quarter, the cowl can be similarly sealed by using the present invention hollow sealers. It should be noted that the present invention hollow sealer is not in any way limited for use in automobile bodies only. It can be used in any other body structures that have body cavities formed between parts that require air and moisture seal from the environment. The expandable sealer material may be heat activated, or activated by UV light or moisture.

It should also be noted that other processing techniques for plastics may also be used in the present invention method for preparing the hollow molded-to-shape expandable sealer. These methods include liquid resin casting, slush molding, steam pressure forming, wrapping and dip coating.

The hollow bladder can be used as is in a body cavity for sealing or can be filled with an internal core material such as foam and then used for sealing. This is determined by the specific application needs.

In an alternate embodiment, a method of using a light weight, low cost expandable sealer is provided by filling the hollow interior of the sealer with a light weight, low cost material. This enables the use of a minimum amount of the higher weight and higher cost skin material in molding the hollow bladder.

In selecting the internal core material, the following characteristics of the material should be considered. First, the internal core material should have low density. Depending on the total interior part volume and manufacturer's weight limitation requirements, the density is probably limited to a maximum of about 0.9 gm/cc. The lowest acceptable density will be determined by the ability of the core to support the blow molded bladder while not producing any deleterious effects. Another important property requirement of the internal core material is sag resistance. Since the purpose of the core is to support the sealer while expanding, it should not deflect to such an extent that intimate contact of the sealer with an intended sealing substrate is jeopardized. Acceptable level of deflection will depend on individual part size and shape. For instance, a part that has little structural stiffness owing to a relatively small cross sectional area will be prone to deflect if the core support material is positioned in a cantilever configuration. However, if the primary function of the core is to prevent collapse of the blow molded sealer, then the material would not require such a high level of sag resistance. In general, to permit

universal application in a variety of shapes, the foam core should deflect minimally even after exposure to a high temperature of 450°F for 30 minutes.

The core material must also have high temperature resistance because the sealer will be exposed to elevated temperatures of up to 450°F. It is important that the core material not degrade when heated to such processing temperatures. Any degradation such as evolution of noxious, caustic or physically harmful decomposition products cannot be allowed. The core material must also have the ability to be introduced into the bladder after blow molding of the bladder is completed. However, it is possible to first mold a hollow bladder and then cut the bladder open to insert a pre-molded foam core. After the foam core insertion, the hollow bladder can be heat bonded together.

When foam is dispensed directly into a blow molded part, the injected foam can be gas blown, syntactic or a combination of the two. The foam production method of the core material must not damage the bladder. For instance, the hollow bladder must not be damaged by excessive pressure produced during the injection cycle, the excessive heat resulting from an exothermic reaction of the foam material, or reaction of raw material chemicals with the blow molded sealer. It is also desirable to have a short cycle time for the core material during its foaming process to accommodate for high volume automobile

productions. Typically, one minute or less is in the range of acceptable cycle time.

The core material can be any suitable foamable material such as polyurea, epoxy, polyisocyanurate and phenolics. In applications where high temperature performance requirement is not necessary, other foamable materials such as polyurethane, polyester, polystyrene and other polymeric foamable materials can also be used.

While the present invention has been described in an illustrative manner, it should be understood that the terminology used is intended to be in a nature of words of description rather than of limitation.

Furthermore, while the present invention has been described in terms of a preferred and an alternate embodiment thereof, it is to be appreciated that those skilled in the art will readily apply these teachings to other possible variations of the invention. For instance, any other material that is not foamable but is light weight, low cost and high temperature resistant can also be used as the core material.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

CLAIMS

1. A hollow molded-to-shape expandable sealer comprising a hollow shell molded of an expandable polymeric material having an external configuration conforming substantially to the configuration of a body cavity in a structure to be sealed from air and moisture penetration.

2. A hollow molded-to-shape expandable sealer according to claim 1, wherein said expandable polymeric material is selected from the group consisting of ethylene vinyl acetate, ethylene propylene diene monomer, styrene butadiene rubber, ethylene carboxylic acid copolymer, butyl rubber and ethylene copolymers or terpolymers.

3. A hollow molded-to-shape sealer according to claim 1, wherein said expandable polymeric material expands when activated by an energy source selected from the group consisting of heat, UV radiation and moisture.

4. A hollow molded-to-shape expandable sealer according to claim 1, wherein said expandable polymeric material expands when exposed to heat.

5. A hollow molded-to-shape expandable sealer according to claim 1, wherein said expandable polymeric material expands when exposed to a temperature of at least 240°F.

6. A hollow molded-to-shape expandable sealer according to claim 1, wherein said expandable polymeric material expands to at least 100% of its original volume.

7. A hollow molded-to-shape expandable sealer according to claim 1, wherein said hollow shell is molded by a method selected from the group consisting of blow molding, rotational molding, liquid resin casting, slush molding, steam pressure forming and gas assisted injection molding.

8. A hollow molded-to-shape expandable sealer according to claim 1, where said hollow shell is molded by a blow molding process.

9. A hollow molded-to-shape expandable sealer according to claim 1, wherein said hollow shell is molded by a rotational molding process.

10. A hollow molded-to-shape expandable sealer according to claim 1, where said expandable polymeric material can withstand a service temperature of at least 240°F.

11. A hollow molded-to-shape expandable sealer according to claim 1, wherein said body cavity to be sealed is selected from the group consisting of A-pillar, motor rail, front body hinge pillar, rocker, B-pillar, rear quarter lower to wheel house, sail, C-pillar, wheel house to quarter, cowl and any other suitable body cavities.

12. A hollow molded-to-shape expandable sealer according to claim 1, wherein said body cavity is a cavity in a vehicle body.

13. A molded-to-shape expandable sealer comprising:

a hollow shell molded of an expandable polymeric material and having an external configuration conforming substantially to the configuration of a body cavity to be sealed, and

an internal core substantially filling the hollow portion of said shell.

14. A molded-to-shape expandable sealer according to claim 13, wherein said expandable polymeric material is selected from the group consisting of ethylene vinyl acetate, ethylene propylene diene monomer, styrene butadiene rubber, ethylene carboxylic acid copolymer and butyl rubber.

15. A molded-to-shape expandable sealer according to claim 13, wherein said expandable polymeric material expands when activated by an energy source selected from the group consisting of heat, UV radiation and moisture.

16. A molded-to-shape expandable sealer according to claim 13, wherein said expandable polymeric material expands when exposed to heat.

17. A molded-to-shape expandable sealer according to claim 13, wherein said expandable polymeric material expands when exposed to a temperature of at least 240°F.

18. A molded-to-shape expandable sealer according to claim 13, wherein said expandable polymeric material expands to at least 100% of its original volume.

19. A molded-to-shape expandable sealer according to claim 13, wherein said expandable polymeric is molded by a method selected from the group consisting of blow molding, rotational molding, gas assisted injection molding, liquid resin casting, slush molding and steam pressure forming.

20. A molded-to-shape expandable sealer according to claim 13, wherein said expandable polymeric is molded by a blow molding process.

21. A molded-to-shape expandable sealer according to claim 13, wherein said expandable polymeric is molded by a rotational molding process.

22. A molded-to-shape expandable sealer according to claim 13, wherein said expandable polymeric material can withstand a service temperature of at least 240°F.

23. A molded-to-shape expandable sealer according to claim 13, wherein said body cavity to be sealed is a cavity from a vehicle body.

24. A molded-to-shape expandable sealer according to claim 13, wherein said body cavity to be sealed is selected from the group consisting of A-pillar, motor rail, front body hinge pillar, rocker, B-pillar, rear quarter lower to wheel house, sail, C-pillar, wheel house to quarter and cowl.

25. A molded-to-shape expandable sealer according to claim 13, wherein said internal core is a thermoset material.

26. A molded-to-shape expandable sealer according to claim 13, wherein said internal core is a light weight material having a density of not more than 0.9 gm/cc.

27. A molded-to-shape expandable sealer according to claim 13, wherein said internal core is a foamable material that forms a cellular structure when filling said hollow portion of said shell.

28. A molded-to-shape expandable sealer according to claim 13, wherein said internal core is blown into said hollow shell through an opening in said shell.

29. A molded-to-shape expandable sealer according to claim 13, wherein said internal core is injected into said hollow shell through an opening in said shell.

30. A method of making a molded-to-shape expandable sealer comprising the steps of:

molding a hollow shell of the expandable sealer with an expandable polymeric material, and

filling substantially the hollow portion of said shell with an internal core.

31. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said expandable polymeric material is selected from the group consisting of ethylene vinyl acetate, ethylene propylene diene monomer, styrene butadiene rubber, ethylene carboxylic acid copolymer, butyl rubber and ethylene copolymers and terpolymers.

32. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said expandable polymeric material expands when activated by an energy source selected from the group consisting of heat, UV radiation and moisture.

33. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said expandable polymeric material expands when exposed to heat.

34. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said expandable polymeric material expands when exposed to a temperature of at least 240°F.

35. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said expandable polymeric material expands to at least 100% of its original volume.

36. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said expandable polymeric material is molded by a method selected from the group consisting of blow molding, rotational molding, liquid resin casting, gas assisted injection molding, slush molding and steam pressure forming.

37. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said expandable polymeric material is molded by a blow molding process.

38. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said expandable polymeric material is molded by a rotational molding process.

39. A method of making a molded-to-shape expandable sealer according to claim 30 further comprising the step of applying said sealer to a body cavity.

40. A method of making a molded-to-shape expandable sealer according to claim 30 further comprising the step of applying said sealer to a body cavity in a vehicle.

41. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said internal core is a foamable material.

42. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said internal core is a light weight material having a density of not more than 0.9 gm/cc.

43. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said internal core is a foamable material that forms a cellular structure when filling said hollow portion of said shell.

44. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said internal core is a foamable material and is flown into said hollow shell through an opening in said shell.

45. A method of making a molded-to-shape expandable sealer according to claim 30, wherein said internal core is a foamable material and is injected into said hollow shell through an opening in said shell.

46. A method of making a molded-to-shape expandable sealer according to claim 30 wherein said step of filling the hollow portion of said shell further comprising cutting said hollow shell into two halves, inserting an internal core and then combining the two halves of the shell together.

47. A hollow molded-to-shape expandable sealer according to claim 1, wherein said hollow shell being filled with a heat-expandable gas that expands upon heating such that the hollow shell is bonded to the body cavity.

48. A hollow molded-to-shape expandable sealer according to claim 47, wherein said heat-expandable gas is air.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/11155

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : B60R 27/00; B62D 29/04; B29D 22/00, 23/00; B32B 3/00
US CL : 296/205, 906; 428/36.5, 36.91, 71, 913
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 49/475.1, 498.1; 52/232; 296/191, 203, 205, 906; 428/35.7, 36.5, 36.9, 36.91, 71, 313.5, 913

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,072,952 (IRRGEHER ET AL) 17 December 1991, figures 1-3 and col. 1, lines 35-55.	1-4, 13-16, 26-27
Y	US, A, 5,344,208 (BIEN ET AL) 06 September 1994, abstract.	12, 23
A	EP, A, 0,061,131 (NISSAN MOTOR COMPANY, LIMITED) 29 September 1992.	
A	EP, A, 0,085,415 (NITTO ELECTRIC INDUSTRIAL CO., LTD.) 10 August 1983.	
A	US, A, 5,274,035 (CHUNDURY) 28 December 1993.	
A	US, A, 3,755,063 (MASSEY ET AL) 28 August 1973.	

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 AUGUST 1996	10 SEP 1996

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Form PCT/ISA/210 (second sheet)(July 1992)★

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/11155

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4,810,548 (LIGNON, SR. ET AL) 07 March 1989.	